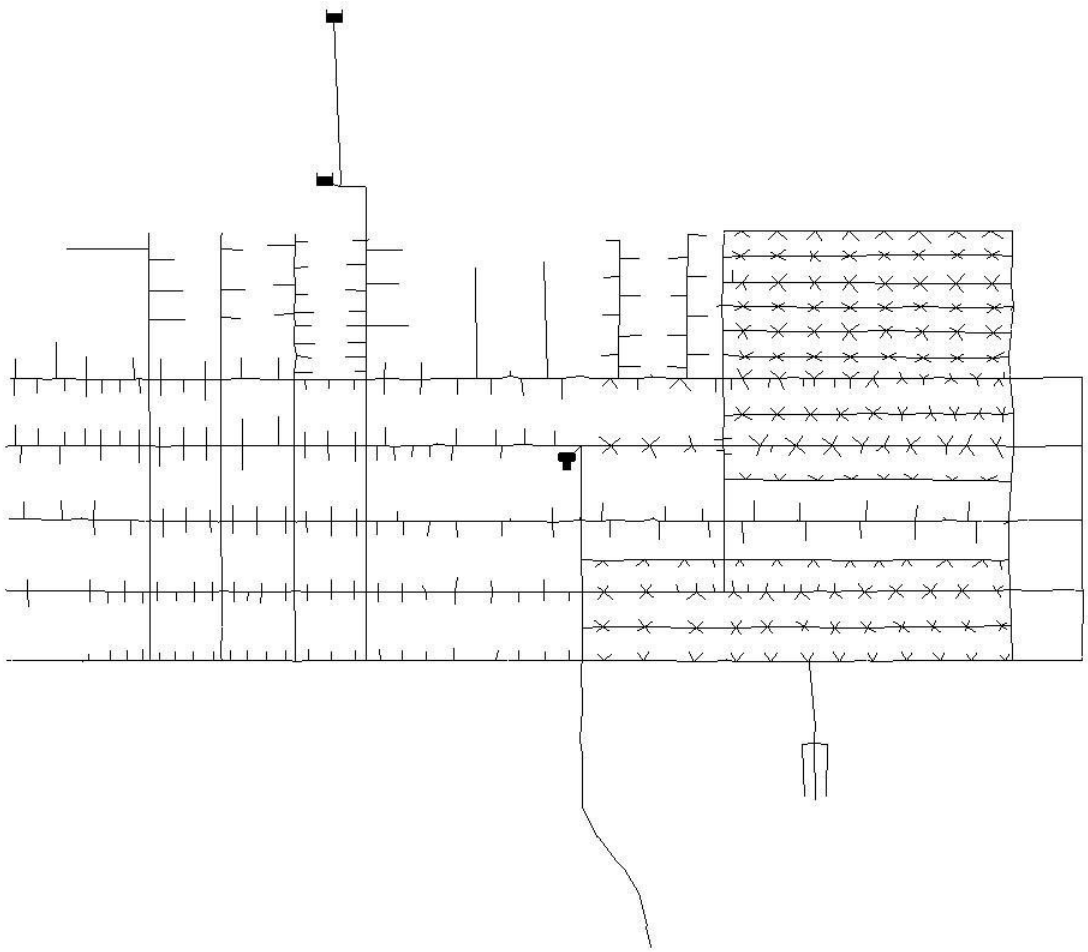
SYSTEM ID: Micropolis

NARRATIVE DESCRIPTION

The Micropolis system is a synthetic system with an average demand of 1.6 MGD. It is part of a larger virtual city including buildings, land use, roadways, and water distribution. The city was created by Brumbelow et al. (2007). The water distribution network is composed of a mixture of pipes dating from 1910 cast iron to 1950 asbestos cement to 1980 ductile iron. A majority of the system is two-inch mains but simulated upgrades have taken place in the “older” portion of the system. A general schematic of the system is shown below. The system has two reservoirs, one tank, eight pumps, and 22.3 miles of pipe.

NETWORK SCHEMATIC:



HISTORY OF THE NETWORK FILE

The Micropolis system was introduced as a component of a virtual city of the same name by Brumbelow et al. (2007) to study infrastructure security. It includes simulated updates over a timeline of 130 years.

ORIGINAL REFERENCE:

Brumbelow, K., Torres, J., Guikema, S., Bristow, E. and Kanta, L., 2007. Virtual cities for water distribution and infrastructure system research. In *World environmental and water resources congress 2007: Restoring our natural habitat* (pp. 1-7). https://doi.org/10.1061/40927(243)469

ABSTRACT: In a society concerned over the possibility of terrorism, secrecy, and security of infrastructure data is crucial. However, research on infrastructure security is difficult in this environment since experiments on real systems can not be publicized. "Virtual cities" are one potential answer to this problem, and a library of these virtual cities is now under development. "Micropolis" is a virtual city of 5000 residents fully described in both GIS and EPANet hydraulic model frameworks. To simulate realism of infrastructure, a developmental timeline spanning 130 years was included. This timeline is manifested in items such as pipe material, diameter, and topology. An example of using the virtual city for simulation of fire protection is presented. The data files describing Micropolis are available from the authors for others' use. A larger city, "Mesopolis," is currently under development and will incorporate additional critical infrastructure dependencies such as electrical power grids and communications. This will supplement the development of further models to account for risks and probability of electrical power failure due to hurricane events. It is hoped that Micropolis, Mesopolis, and additional virtual cities will serve as a "hub" for the development of further research models.

ADDITIONAL CITATIONS:

The original publication Brumbelow et al. (2007) and by inference the Micropolis system have been cited by 92 additional authors. These may be accessed by moving your cursor over the following link while simultaneously depressing the CTRL key on your keyboard: 92 Citations.

AVAILABLE INFORMATION

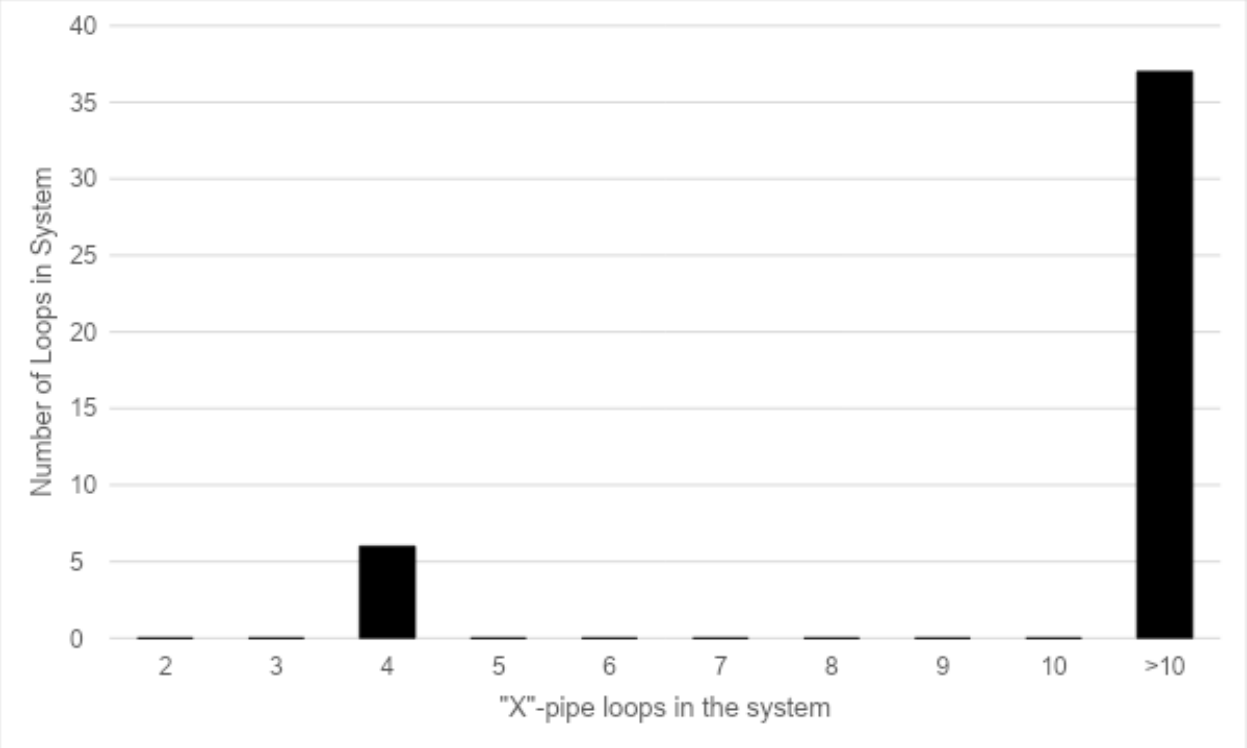
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	No
Background map	No
Elevation data	Yes
Pipe data	Yes
Pipe material	Yes
Pipe age	Yes
Pipe pressure class	No
Nominal or actual diameters	Nominal
Pump data	Yes
Useful horsepower	No
Pump operating curves	Yes
Tank data	Yes
Elevation data	Yes
Stage storage curves	No
Water quality information	No
Valve data	NA
PRV/FCV data	Yes
Isolation valve data	Yes
Hydrant data	Yes
Demand data	Yes
Total system demand	Yes
Nodal demand data	Yes
Temporal data demands	Yes
System leakage	No
Hydraulic data	No
Hydraulically calibrated model	
Field hydraulic calibration data	
Water quality data	No
Disinfection method	
Chlorine residual data	
Booster station data	
Fluoride/Chloride field data	
Water quality calibrated model	
Operational data	Yes
SCADA datasets	No
Operational rules	Yes

SYSTEM CLASSIFICATION:

PIPE/LOOP HISTOGRAM:

Hoagland et al. (2015) designed a network classification algorithm for use in classifying water distribution systems as either “branched,” “looped,” or “gridded” based on the observed frequency of network loops with different numbers of distinct pipe segments. The frequency distribution for the Micropolis system is provided below. Using this information, Hoagland et al., classified this system as being a BRANCHED system.

# Total Pipes:	1823
# Branch Pipes:	972
Ratio (Branch Pipes / Total Pipes):	0.53



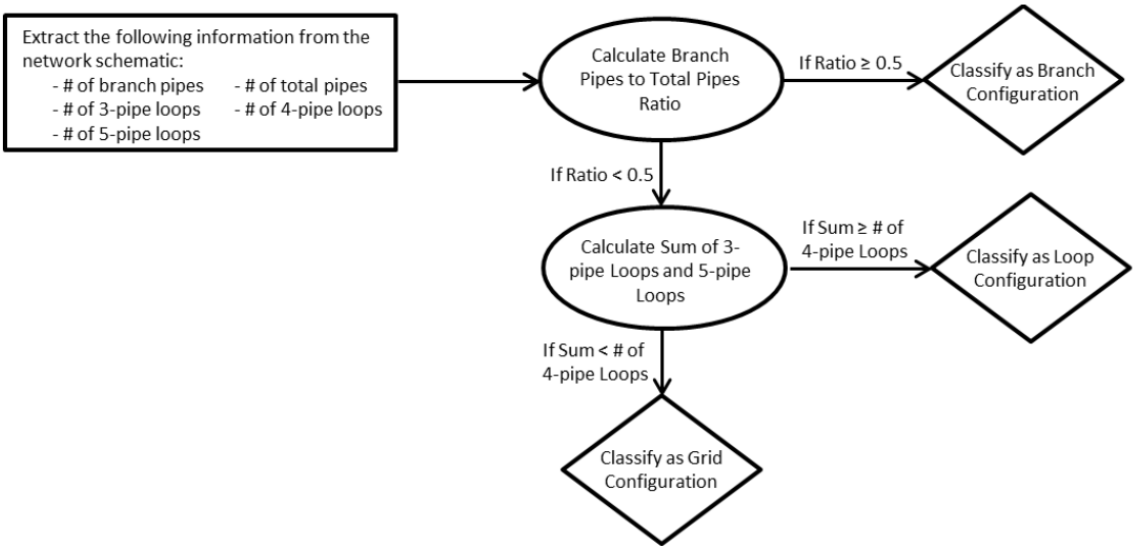


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

Hoagland, Steven & Schal, Stacey & Ormsbee, Lindell & Bryson, Lindsey. (2015). Classification of Water Distribution Systems for Research Applications. 696-702. 10.1061/9780784479162.064.

NETWORK STRUCTURE METRICS:

Building on the work of Hoagland et al., (2015), Hwang & Lansey (2017) created an expanded classification system that allows for further classification of a system as being either a transmission or distribution branched, looped, gridded, or hybrid system. Their algorithm streamlines the classification system by removing unnecessary nodes that do not contribute to the structure of the system while still retaining their use as intermediate points for demand data entry. A full description of the algorithm can be found in the cited reference.

Application of the Hwang and Lansey classification algorithm to the system yields the following statics and associated classification:

Parameter	Value
Edges	1619
Pipes	1361
Nodes	1577
Average Diameter	128
Reduced Nodes	357
Reduced Edges	399
Branched Edges	907
Branched Index	0.7
Meshed Connectedness	0
Reduced Meshed Connectedness	0.06
Link Density	0
Average Node Degree	2.1
Hwang & Lansey Classification	Distribution Branch

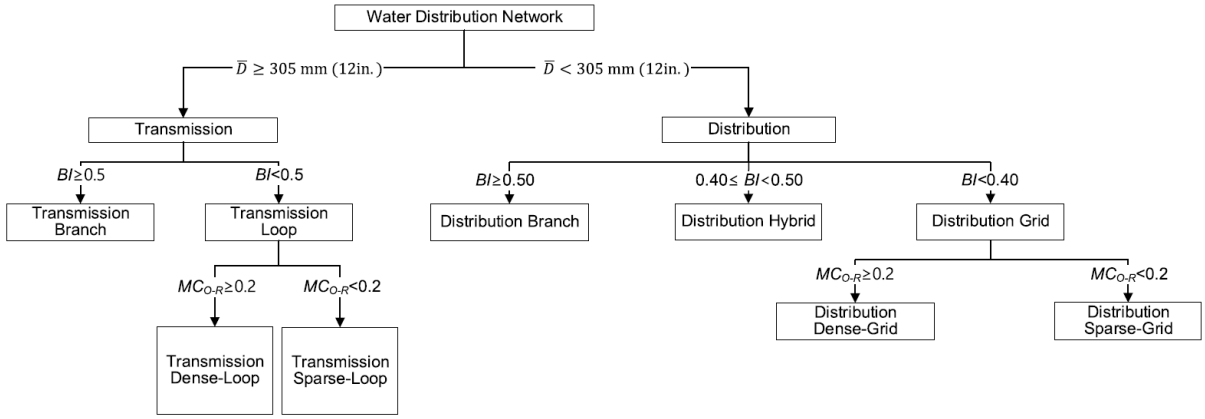


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

Hwang H. & Lansey, K. (2015) “Water distribution system classification using system characteristics and graph theory metrics.” *Journal of water resource planning and management* 143(12) https://doi.org/10.1061/(ASCE)WR.1943-5452.0000850

DETAILED DATA SUMMARIES

PHYSICAL ASSETS:

Asset Type:	# of Assets
Master Meters	0
Tanks	1
Pumps	8
Water Sources	2

NETWORK CHARACTERISTICS:

# Total Pipes:	1823
# Junctions	1574
# Reservoirs	2
# Tanks	1
# Regulating Valves	0
# Isolation Values	196
# Hydrants	52
Elevation Data	YES

PIPE DATA:

Diameter (in)	Length (ft)
0.8	30419
1	110
2	16547
3	414
4	25026
6	15158
8	7880
12	24716
48.604	39

PUMP DATA:

Pump Horsepower	NO
Pump Curves:	YES

DATA FILE ATTRIBUTES:

ATTRIBUTE		UNITS
Pipe Length & Diameter	X	Feet & inches
Pipe Age		
Node Elevation	X	Feet
Node Demand	X	GPM
Valves		
Hydrants		
Tank Levels		
Tank Volume		
PRVs		
WTP		
WTP Capacity		
Pump Data		